IGNITE the night sky electronically!

Using Stellarium to present Astronomy concepts in your classroom.

A planetarium software like Stellarium is very useful as it is always clear weather in the computer and you can speed up time to show days and months in a class period. You can also translocate yourself to other parts of the planet to view the sky from other places.

Stellarium is a freely downloadable program for Windows and Mac. It is provided on this disk for you but you can download the newest version from http://stellarium.org. A user's manual is provided at http://stellarium.org/wiki/index.php/Category:User%27s_Guide and a copy is included on this disk.

Some of the 'sky' standards in the GPS.
S4E1. Students will compare and contrast the physical attributes of stars, star patterns, and planets. b. Compare the similarities and differences of planets to the stars in appearance, position, and number in the night sky.
c. Explain why the pattern of stars in a constellation stays the same, but a planet can be seen in different locations at different times.
S4E2. Students will model the position and motion of the earth in the solar system and will explain the role of relative position and motion in determining sequence of the phases of the moon.
a. Explain the day/night cycle of the earth using a model.
b. Explain the sequence of the phases of the moon.
S6E2. Students will understand the effects of the relative positions of the earth, moon and sun.
a. Demonstrate the phases of the moon by showing the alignment of the earth, moon, and sun.
b. Explain the alignment of the earth, moon, and sun during solar and lunar eclipses.
c. Relate the tilt of the earth to the distribution of sunlight throughout the year and its effect on climate.

Getting Started

When you open Stellarium, it might figure out where you are and what time it is from your computer. If it does not, or if you want to change locations – do the following:
Use F6 to access the Location Window. Or on a Macintosh OS X, go to left side and hover over compass needle image to access the Location Window.
Use F5 to access the Date/Time Window to set the time to a different time.

- By default, you are pointing South with a 60 degree field of view (FOV). To change where you are pointing you can:
- Click and drag with the mouse.
- Use the arrow keys.
- To zoom in and out or to select an object you can:
- Page up/page down to zoom
- Use mouse wheel to zoom in/out.
- Select an object with left mouse click and unselect with right mouse click.
- Use the forwardslash (/) to zoom in to selected object. (Very cool on the planets!!)
- Use the backslash (\) to return to original default field of view.

Move time forward faster – click the double forward arrow at the bottom of the screen. If you click again, you can make time go even faster. And faster still. You can make it go fast enough to make yourself a bit ill! Use the 'L' key to speed up.

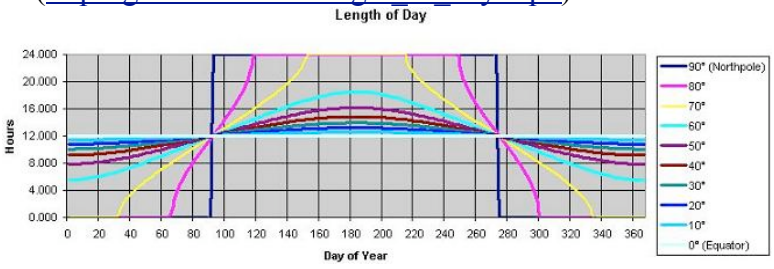
There are MANY more features – but let's look at how to use Stellarium to show the altitude of the Sun changes during the day and that the Sun is highest in the sky when it is due South in the Northern hemisphere. Azimuth is a way of numerically specifying NSEW. Azimth = 0 for North, 90 for East, 180 for South, ad 270 for West.

- Set date to March 21. Set time to around 7:30 am. (7:52 AM works well for Columbus). You should see the Sun rising near the East. You may need to scroll over to the East to see it.
- Click fast forward 3 times. (or hit J three times). You may have to scroll around on the screen to follow the Sun.
- Click on the Sun so you can see its vital statistics on the screen. What is the azimuth when the altitude is the highest? (click 'K' to slow time down to normal speed again)
- Return to around sunrise on March 21.
- Use the ']' key to advance time by about a week. Keep advancing time until you are near the beginning of May.
- Run time through a day and find the azimuth when the Sun is highest. You should find it is again 180 degrees – or due South – for observers in the Northern hemisphere.

Depending on your students, you may need to reinforce this with more than two examples.

Day Length & Seasonal Climate Variations

Once you have mastered following the Sun and observing its position at its highest point, you can start to relate seasonal climate variations to the length of day, which in turn is related to the tilt of the Earth. Longer days = more hours of sunshine = warmer. Stellarium can be used to demonstrate the variations in the length of day at different times of year. Ask your students to find how long the day is – by defining the beginning of daylight to be when the Sun is at or above an altitude of 0 degrees. You can break up your class into groups and ask them to find out the sunrise and sunset times for a few dozen days and then plot the length of day as a function of year – or you can demonstrate day length using your own projector and ask students to record the data.
The graph will depend on your latitude as shown here. This graph assumes Day 0 is December 21, the shortest day of the year. (http://gandraxa.com/length_of_day.aspx)



The nice thing is that once you click on the Sun, you don't have to follow the Sun in the sky to see its altitude. The altitude will update even if you can't see the Sun on the screen.

Planets vs. Stars

The word planet is originally Greek for wandering star. What does this mean? And how can we demonstrate this to students who may live in light polluted environments where it is not feasible to make regular observations of the night sky? Compare and contrast the position of highly recognizable constellations with that of some planets over a few months or a few years using Stellarium. This helps you get at S4E1c.

- Go to January 27, 2010, 20:00 or so. You should see Mars rising in the East. (check that your options for show planet labels is on. hit 'p' or click planet button on bottom menu). Also turn on the constellation lines ('c') and constellation labels ('v'). You will see that Mars is in the constellation Cancer.
- Ask your students to sketch the relative position of the stars in Cancer and Mars.
- Advance the night sky 6 or 7 hours and continue to follow Mars.
- Ask your students to repeat their sketch of the stars of Cancer and Mars.
- Are the relative positions the same at the beginning of the night and towards the end of the night?
- Advance to February 12, 2010 around 19:00. Look in the southeast. You should again see Mars in the constellation of Cancer. Is Mars in the same spot relative to the other stars in the constellation? [Teacher note – a careful observer will probably be able to see changes in the position of the Moon with respect to the stars in one night, but a naked eye observer is not going to notice a difference for the planets in one night.]
- You can use the ']' key to step forward a week at a time and watch the relative position of Mars change with respect to the stars in the constellation Cancer. (You can also see it gets lighter for the same time of night!)

If you go far enough into April, you may notice that Mars stops heading Westward and reverses directions with respect to the stars in Cancer. Normally the planets will travel Eastward with respect to the stars. That time interval when Mars (or other planets) 'reverse' direction and head Westward is called retrograde motion. It happens when the Earth, in its orbital motion around the Sun, begins to catch-up to the planet in its orbit. See this simulation for a better view (http://www.astro.illinois.edu/projects/data/Retrograde/). This year, Mars is undergoing retrograde motion from December 20, 2009 to March 10, 2010. So, when we started this activity... Mars was already undergoing retrograde motion. Retrograde motion is not part of the standards until high school Astronomy.

You may also use Stellarium to address certain aspects of S4E1b - in that some of the planets are bright and that they may change brightness (note how Mars gets dimmer as Earth and Mars move farther apart between January and April 2010. What you can't use Stellarium for is the 'lack of twinkle' most planets have compared to the stars. The distance of the stars makes them appear very small; so small that any piece of pollen can block the light for an instant and cause the brightness of the star to appear to vary – or twinkle. Planets are much closer (by contrast) and have a finite and measurable disk. Small fluctuations in the atmosphere will affect the overall appearance of the planet much less so they don't twinkle.

If you want another example of planetary motion with respect to the stars – look for Jupiter in Capricorn in the Southwest around 20:00, Dec. 10, 2009. You can see it for a few weeks at the same time of night. You may have noticed Jupiter in the Western sky around sunset this winter!

Phases of the Moon

Fourth graders are supposed to be able to explain the sequence of the phases and sixth graders are supposed to relate the phases of the moon to the relative positions of Earth, Moon, and Sun. There are fabulous 3-D kinesthetic activities related to the phases of the Moon. (e.g. http://www.learner.org/teacherslab/pup/act_moonphase.html) You can also use Stellarium to show the relative positions of the Sun and Moon as seen from the Earth observer to help show the progression of the phases of the Moon, and why certain phases are visible at certain times of day in certain parts of the sky (High School level).

- Go to February 10, 2010, at noon. Look in the South. You should see the Sun and Moon. Make a note of the relative position between the Sun and Moon.
- Click on the Moon.
- Quick – make a prediction. What do you think the Moon will look like?
- Zoom in on the Moon using '/'. Does your prediction match the appearance?
- Zoom back out using '\'.
- Go forward one day. (=) Make your prediction about what you think the Moon will look like. Make a note of the relative position of the Moon and Sun in the sky.
- Go forward to about the 20th of February. Note the relative position of the Moon and Sun in the sky. You might have to scroll around to get them both in the view at once. What do you think the Moon will look like? Zoom in to check.

[Teacher note – many students may not realize that the Moon is visible during the daytime for so many days of the month. The reason may be that the Moon is not in the same spot in the sky at the same time of day!]

- Go the the 22nd of February. This is what is known as 1st quarter moon. Note that the Moon is rising right around noon time. Run time forward to see a full day. How does the relative position of the Moon and Sun change during the day? (You may want to turn on the constellation name and patterns using c, and v to help since you can't get both the Sun and Moon in the same 60 degree field of view.)
- When the Sun is setting, where is the Moon in relation to the Sun?
- After sunset, can you still see the Moon? Is the same side of the Moon lit up? How many hours after the Sun set did the Moon set?
- Make a prediction, what will be the relative position in the sky of the Sun and Moon when the Moon is in the full moon phase? (Feb. 27, go to a time just before sunset to check your answer)
- Go to March 3, 2010 around 23:00. Look to the East and zoom in on the Moon. Do you think the Moon will set before the Sun rises? What should the relative position of the Moon and Sun in the sky be to make this phase?
- Zoom back out (\) and let the night progress. Does the Sun rise first, or does the Moon set first?

I hope you can see how using Stellarium (or other planetarium software) might provide another dimension for teaching various abstract ideas about the sky.

Common Key Strokes for These Exercises

K	Return to normal speed	P	Show planet names	F5	Date/Time
J	Go backwards in time or slow down forwards time	C	Show constellation outlines	F6	Location on Earth.
L	Go forward in time or slow down backwards time	v	Show constellation names	/	Zoom in on object
'='	Go Forward one day	G	Show ground	\	Zoom back out
'-'	Go Back one day	Q	Show NSEW directions		
[	Go forward one week	A	Show atmosphere (if you turn off the atmosphere during the day time, you will see the stars instead of blue sky!)		
]	Go back one week				

Want to learn more astronomy and how to use real astronomy data in your high school classroom? Apply for a GEARS summer workshop. Applications are available at the GEARS booth at GSTA or by visiting the website (http://cheller.phy.georgiasouthern.edu/gears/) and clicking on the Workshops link.

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